CONTROL SYSTEMS
(AEIE 2204)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

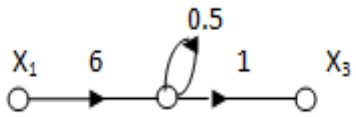
Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) A system has a pole at s= - 5. The unit impulse response of the system
(a) linearly increases with time (b) exponentially increases with time
(c) exponentially decreases with time (d) linearly decreases with time

(ii) For a unit step input, a unity feedback system with an open loop transfer function $20/(s^2+2s+5)$ has a steady state error
(a) 0.6 (b) 1
(c) 4 (d) 0.2

(iii) The overall transmittance X_3/X_1 of the following system is



(a) 3.5 (b) 7.5
(c) 12 (d) 10

(iv) A unity feedback system with open loop transfer function G(s) = 4 / [s(s+p)] is critically damped. The value of the parameter p is
(a) 2 (b) 6
(c) 4 (d) 1

(v) For a system gain margin is positive and at gain crossover frequency 3 rad/sec the phase angle is - 115°. The system is
(a) marginally stable (b) unstable
(c) stable (d) cannot be predicted

(vi) The phase margin of a system is used to specify
(a) frequency response (b) relative stability
(c) absolute stability (d) time response

(vii) A unity feedback system has open loop transfer function $G(s) = 10/[s^2(1+0.2s)(1+0.5s)]$. The polar plot of this system starts with
(a) magnitude 0, phase -270°
(b) magnitude infinity, phase -90°
(c) magnitude 0, phase -90°
(d) magnitude infinity, phase -180°

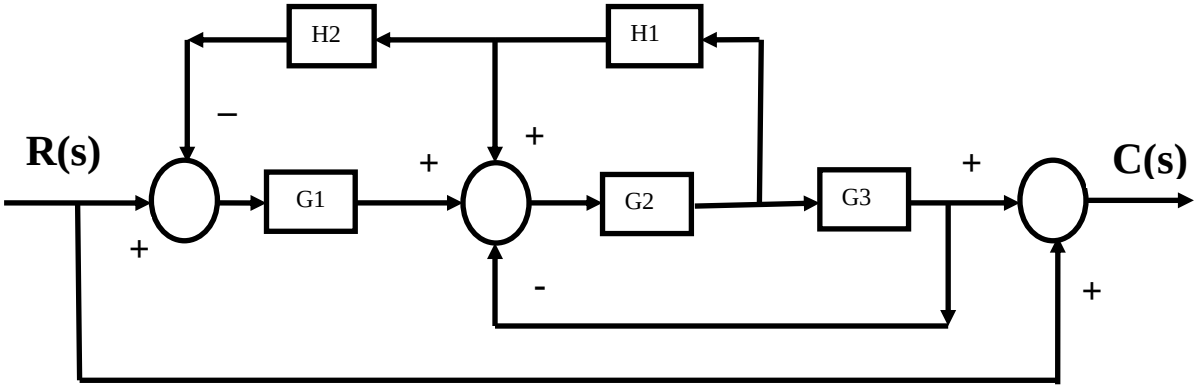
(viii) If the characteristic equation of a system is $s^2 + 2s + 4 = 0$, the time required to attain the 1st undershoot of unit step response of the system is
(a) 2 sec
(b) 5.55 sec
(c) 1.56 sec
(d) 3.65 sec

(ix) The initial slope of Bode plot for a transfer function having a zero at origin is
(a) -40db/dec
(b) -20db/dec
(c) +20db/dec
(d) +40db/dec

(x) A second order system exhibits 100% peak overshoot. Its damping ratio is
(a) 1
(b) less than 1
(c) 0
(d) greater than 1.

Group – B

2. (a) Find the overall transfer function of the system, having block diagram as shown in fig. below, using block reduction technique.



(b) For the same block diagram as mentioned in above, draw the signal flow graph and hence find the overall transmittance using Mason's gain formula.

6 + 6 = 12

3. (a) Show how synchro is used for the measurement of angular position difference in control system.

(b) Find out the overall transfer function and draw the block diagram of field controlled dc servo motor considering angular speed of the shaft as output and applied voltage to the field as input.

7 + 5 = 12

Group – C

4. (a) A negative feedback control system has forward path transfer function $k/(s+kH)$ and feedback path transfer function $1/s$. For the unit step response of the system, peak time is 1.5 sec and percentage peak overshoot is 20%. Find the natural frequency of oscillation and damping ratio of the system. Hence find the values of k and H.

   (b) The characteristic equation of a system is given by $s^4+10s^3+5s^2+3s+k=0$. Using Routh-Hurwitz criteria find the range of k for the system to be stable. Find the frequency of oscillation of the system for the system to be marginally stable.

7 + 5 = 12

5. For a unity feedback system having open loop transfer function $G(s) = k/[s(s^2 + 6s +25)]$, sketch the root locus plot by finding the required parameters. Hence comment on the stability of the system.

(10 + 2)= 12

Group – D

6. (a) Construct the Bode plot on the graph paper for a unity feedback control system having open loop transfer function $G(s) = 10^6 / [s(1+0.1s)(s+1000)]$.

   (b) From the above plot find the gain margin, phase margin, gain cross-over frequency and phase cross-over frequency. Hence comment on the stability of the system.

7 + 5 = 12

7. (a) Sketch the Nyquist plot for a unity feedback system having open loop transfer function $G(s) = k / [s(Ts – 1)]$.

   (b) Comment on the closed loop stability of the above system.

10 + 2 = 12

Group – E

8. (a) The transfer function of a system is $Y(s)/ U(s) = 1/ (s^2 + 2s +5)$. Find the state equation and output equation of the system using state variable analysis. Hence draw the state block diagram of the system.

   (b) In the state space model of a system, matrix A is given by

$$A = \begin{bmatrix} -1.8124 & -0.2324 \\ 9.6837 & 1.4697 \end{bmatrix}$$

   Find the stability of the system.

(6 + 3) + 3 = 12

9. (a) In the state variable model of a linear time invariant system, matrices are given by

$$A = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} \quad B = \begin{bmatrix} 0 \\ 1 \end{bmatrix} \quad C = \begin{bmatrix} 1 & 0 \end{bmatrix} \quad D = 0$$

Check the controllability and observability of the system.

(b) What are the differences between state variable approach and transfer function approach for representation of a system?

7 + 5 = 12

Department & Section	Submission Link
AEIE	https://classroom.google.com/c/MzEyMTkxNzI3MDAx/a/MzcxNjU3NTM3OTI0/details